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TITLE: Electric generator for generating electric power by manual labor has output control apparatus which limits increase in output electric current if output voltage exceeds predetermined upper limit voltage

PATENT-ASSIGNEE: SANYO DENKI KK[SAOL]

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ABSTRACTED-PUB-NO: JP2003009596A

BASIC-ABSTRACT:

NOVELTY - An output electric current is passed to a load so that output electric current might fluctuate in proportion of the change in an output voltage, until the output voltage is stabilized by an output control apparatus (2). The output control apparatus limits the increase in output electric current if the output voltage exceeds predetermined upper limit voltage.

USE - For generating electric power by manual labor.

ADVANTAGE - Prevents overcurrent from flowing to load. Also prevents

application of surplus load to operator.

DESCRIPTION OF DRAWING(S) - The figure shows the circuit diagram electric generator. (Drawing includes non-English language text).

Output control apparatus 2

CHOSEN-DRAWING: Dwg.1/3

TITLE-TERMS: ELECTRIC GENERATOR GENERATE ELECTRIC POWER
MANUAL LABOUR OUTPUT

CONTROL APPARATUS LIMIT INCREASE OUTPUT ELECTRIC
CURRENT OUTPUT

VOLTAGE PREDETERMINED UPPER LIMIT VOLTAGE

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(71) 出願人 000180025

山洋電気株式会社

東京都豊島区北大塚一丁目15番1号

(72) 発明者 松崎 昭憲

東京都豊島区北大塚一丁目15番1号 山洋
電気株式会社内

(72) 発明者 山田 浩

東京都豊島区北大塚一丁目15番1号 山洋
電気株式会社内

(74) 代理人 100091443

弁理士 西浦 ▲嗣▼晴

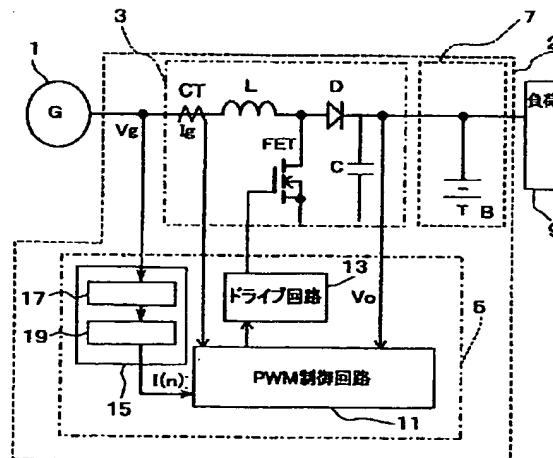
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(54) 【発明の名称】 人力発電装置

(57) 【要約】

【課題】 負荷が大きくなった場合でも、スムーズに発電することができる人力発電装置を提供する。

【解決手段】 電圧範囲判定手段17が、人力直流発電機1の出力電圧 V_g が低電圧範囲、中間電圧範囲及び高電圧範囲のいずれの電圧範囲にあるのかを判定する。電流指令決定出力手段19は、電圧範囲判定手段17の判定結果により、人力直流発電機1の出力電圧が低電圧範囲にあるときには、出力電流を0にするか又は人力直流発電機を動かす人間に実質的に負荷を与えない値にする電流指令を出力し、出力電圧 V_g が中間電圧範囲にあるときには、出力電圧の増減に応じて出力電流を増減させ、出力電圧 V_g が高電圧範囲にあるときには、出力電流を予め定めた値に制限する電流指令を出力する。このようにして得られた電流指令でPWM制御回路11を制御し、直流電圧変換回路3の中のFETを駆動する。



【特許請求の範囲】

【請求項1】 人力で発電する人力発電機と、
前記人力発電機の出力電流を制御する出力制御装置とを
備えた人力発電装置であって、

前記出力制御装置が、前記人力発電機の出力電圧が安定
するまでは、実質的に負荷に出力電流を流さず、前記出
力電圧が安定した以降は前記出力電圧の増減に比例して
出力電流が増減するように前記負荷に出力電流を流し、
前記出力電圧が予め定めた上限電圧を超えると前記出力
電流の増加を制限するように構成されていることを特徴
とする人力発電装置。

【請求項2】 人力で直流電力を発電する人力直流発電
機と、

前記人力直流発電機の出力電流を制御するために電流指
令に応じて前記出力電圧を昇圧または降圧する直流電圧
変換回路及び前記出力電圧を入力として前記電流指令を
出力する電流指令発生手段を有する出力制御装置とを備
えた人力発電装置であって、

前記電流指令発生手段は、前記人力直流発電機の前記出
力電圧が予め定めた第1の設定電圧未満の低電圧範囲に
あるときには、前記出力電流を0にするか又は前記人力
直流発電機を動かす人間に実質的に負荷を与えない値に
する電流指令を出力し、前記出力電圧が前記第1の設定
電圧以上で前記第1の設定電圧よりも高い第2の設定電
圧以下の中間電圧範囲にあるときには、前記出力電圧の
増減に応じて前記出力電流を増減させる電流指令を出力
し、前記出力電圧が前記第2の設定電圧より大きくなる
高電圧範囲にあるときには、前記出力電流を予め定めた
値に制限する電流指令を出力するように構成されている
ことを特徴とする人力発電装置。

【請求項3】 前記電流指令発生手段は、前記出力電圧
が前記低電圧範囲、前記中間電圧範囲及び前記高電圧範
囲のいずれの電圧範囲にあるのかを判定する電圧範囲判
定手段と、

前記電圧範囲判定手段の判定結果により、前記人力直流
発電機の前記出力電圧が前記低電圧範囲にあるときに
は、前記出力電流を0にするか又は前記人力直流発電機
を動かす人間に実質的に負荷を与えない値にする電流指
令を出力し、前記出力電圧が前記中間電圧範囲にあると
ときには、前記出力電圧の増減に応じて前記出力電流を増
減させるように予め定めた演算式または予め定めた人力
直流発電機の出力電圧と出力電流との関係を定めたデー
タに基づいて電流指令を出力し、前記出力電圧が前記高
電圧範囲にあるときには、前記出力電流を予め定めた値
に制限する電流指令を出力する電流指令決定出力手段と
から構成されていることを特徴とする請求項2に記載の
人力発電装置。

【請求項4】 前記電圧範囲判定手段は、発電を開始し
てから予め定めた時間が経過するまで判定動作を行わな
いように構成されている請求項3に記載の人力発電装

置。

【請求項5】 前記直流電圧変換回路の出力で充電され
る蓄電池を備え、

前記出力制御装置は前記蓄電池を電源として動作するよ
うに構成されている請求項2に記載の人力発電装置。

【請求項6】 前記電流指令決定出力手段は、所定の周
期で電流指令を決定し、決定した前回の電流指令と今回
の電流指令とを平均した電流指令を出力する電流指令平
均化手段を更に備えていることを特徴とする請求項3に
記載の人力発電装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、人力で発電する人
力発電装置に関するものである。

【0002】

【従来の技術】従来の人力を利用した人力発電装置で
は、人力発電機を人力で駆動した場合、負荷電圧・電流
を一定にする制御を行っている。このような制御でも、
負荷が小さいときには、特に問題は生じない。

【0003】

【発明が解決しようとする課題】しかしながら負荷が、
100W程度以上になると、足踏み式の人力発電機であ
っても、当初から負荷に電力を供給しようすると、負
荷が重くなり、運転者の負担が大きくなりすぎて、スム
ーズな発電をすることができなくなり、最悪の場合に
は、脱調状態となってスムーズな発電動作を行なえな
くなる問題があった。

【0004】本発明の目的は、負荷が大きくなった場合
でも、スムーズに発電することがでできる人力発電装置
を提供することにある。

【0005】本発明の他の目的は、発電当初における運
転者の負荷を軽減して、円滑な発電を可能とする発電装
置を提供することにある。

【0006】

【課題を解決するための手段】本発明は、人力で発電す
る人力発電機と、人力発電機の出力電流を制御する出力
制御装置とを備えた人力発電装置を改良の対象とする。
本発明においては、出力制御装置を、人力発電機の出力
電圧が安定するまでは、実質的に負荷に出力電流を流さ
ず、出力電圧が安定した以降は出力電圧の増減に比例し
て出力電流が増減するように負荷に出力電流を流し、出
力電圧が予め定めた上限電圧を超えると出力電流の増加
を制限するように構成する。このようにすると、人力発
電機の出力がある程度安定するまでは、負荷に電力が供
給されないで、運転者は無理無く人力発電機の回転数を
増大させていくことができる。出力電圧がある程度安
定した状態になった後に、出力電流を負荷に流すように
すると、人力発電機の回転部の慣性力が大きくなってい
るため、比較的大きな負荷に電流を流したとしても、運
転者の負担が極端に大きくなることはなく、必要な

電力を負荷に供給しながら、滑らかに出力を増減することができる。また本発明においては、出力電圧が予め定めた上限電圧を超えると、出力電流の増加を制限するため、運転者に過剰な負荷がかかって脱調状態になるのを防止できだけでなく、負荷に過電流が流れるのを防止することができる。

【0007】より具体的なレベルで見ると、本発明は、人力で直流電力を発電する人力直流発電機と、人力直流発電機の出力電流を制御するために電流指令に応じて出力電圧を昇圧または降圧する直流電圧変換回路及び出力電圧を入力として電流指令を出力する電流指令発生手段を有する出力制御装置とを備えた人力発電装置を改良の対象とする。この場合において、電流指令発生手段を、人力直流発電機の出力電圧が予め定めた第1の設定電圧未満の低電圧範囲（発電の初期的状態）にあるときには、出力電流を0にするか又は人力直流発電機を動かす人間に実質的に負荷を与えない値にする電流指令を出力し、出力電圧が前記第1の設定電圧以上で第1の設定電圧よりも高い第2の設定電圧以下の中間電圧範囲にあるときには、出力電圧の増減に応じて出力電流を増減させる電流指令を出力し、出力電圧が第2の設定電圧（一例としては、負荷の定格電圧の近傍に定める）より大きくなる高電圧範囲にあるときには、出力電流を予め定めた値に制限する電流指令を出力するように構成する。このようにすると、電流指令発生手段を簡単に構成することができる。

【0008】また電流指令発生手段は、人力直流発電機の出力電圧が低電圧範囲、中間電圧範囲及び高電圧範囲のいずれの電圧範囲にあるのかを判定する電圧範囲判定手段と、電圧範囲判定手段の判定結果により、人力直流発電機の出力電圧が低電圧範囲にあるときには、出力電流を0にするか又は人力直流発電機を動かす人間に実質的に負荷を与えない値にする電流指令を出力し、出力電圧が中間電圧範囲にあるときには、出力電圧の増減に応じて出力電流を増減させるように予め定めた演算式または予め定めた出力電圧と出力電流との関係を定めたデータに基づいて電流指令を出力し、出力電圧が高電圧範囲にあるときには、出力電流を予め定めた値に制限する電流指令を出力する電流指令決定出力手段とから構成することができる。このように電圧範囲と予め定めた演算式または予め定めた出力電圧と出力電流との関係を定めたデータとに基づいて電流指令を出力する構成を採用すると、より高い精度で出力電流を制御することができる。

【0009】なお人力直流発電機の出力電圧が中間電圧範囲にあるときに、出力電圧の増減に応じて出力電流を増減させる電流指令は、電圧の増加に対して直線的に増加するように定めてもよいが、人への負担やその他の観点より考慮して非直線的に増加させるようにしてもよいのは勿論である。

【0010】なお電圧範囲判定手段は、発電を開始して

から予め定めた時間が経過するまでは、判定動作を行わないように構成する。このようにすると、発電開始時に出力電圧が安定するまでは、判定動作を行わないので、電圧範囲の判定精度及び判定の信頼度を高めることができる。

【0011】また直流電圧変換回路の出力で充電される蓄電池を設け、出力制御装置をこの蓄電池を電源として動作するように構成することができる。蓄電池を出力制御装置の電源とすると、直流電圧変換回路の入力電圧が低い状態であっても、出力制御装置は正しく動作するため、出力制御装置の電源が不安定なことが原因になって発生する誤動作を防止することができる。なおこの蓄電池は、僅かではあるが負荷への電力供給に寄与する。

【0012】また前述の電流指令決定出力手段は、所定の周期で電流指令を決定し、決定した前回の電流指令と今回の電流指令とを平均した電流指令を出力する電流指令平均化手段を更に備えているのが好ましい。このような電流平均化手段を設けると、一時的に人力直流発電機の出力電力が増減するようなことがあっても、平均化されるため、負荷への出力電力が大きく変動するのを防止することができ、結果として運転者の人体にかかる過負荷も抑制することができる。ここで電流指令平均化手段の平均化手法は、単純な算術平均の他に加重平均などの平均化手法を含めることができる。

【0013】

【発明の実施の形態】以下、図面を参照して本発明の実施の形態を詳細に説明する。図1は、本発明の人力発電装置の実施形態の一例を示す回路図である。図1において、符号1で示した部材は、人力を利用する手回し又は足踏み式等の人力直流発電機であり、符号2で示した部分は、この人力直流発電機1の出力電流を制御する出力制御装置である。この出力制御装置2は、人力直流発電機1の出力電圧が安定するまでは、実質的に負荷9に出力電流を流さず、出力電圧が安定した以降は出力電圧の増減に比例して出力電流が増減するように負荷9に電流を出力し、出力電圧が予め定めた上限電圧を超えると出力電流の増加を制限するように構成されている。本実施の形態では、人力発電機として、人力直流発電機1を用いているが、人力発電機として、交流発電機を用いる場合には、人力発電機の出力側に整流回路を配置すればよい。

【0014】出力制御装置2は、人力直流発電機1の出力電圧を昇圧する直流電圧変換回路3と、人力直流発電機1の出力電圧を入力として電流指令を出力する電流指令発生手段15を含んで構成されて直流電圧変換回路3を制御する制御信号を出力する制御信号発生回路5と、蓄電池Bを備えた蓄電池回路7とを備えている。この例の直流電圧変換回路3は、いわゆるDC-DCコンバータと呼ばれるスイッチングレギュレータにより構成された昇圧型直流電圧変換回路である。この直流電圧変換回

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路3は、人力直流発電機1の出力端に一端が接続されたリアクトルLと、このリアクトルLに流れる電流I_gを検出する電流検出器CT1と、リアクトルLの他端にアノードが接続されたダイオードDと、リアクトルLの他端にドレインが接続されアースにソースが接続された電界効果トランジスタ即ちFETと、ダイオードDのカソードとアース間に接続されたコンデンサCとから構成されている。FETのゲートには、制御信号発生回路5中の後述するドライブ回路13の出力が入力される。この直流電圧変換回路3では、FETがオン状態にあるときにリアクトルLにはFETを通して電流が流れ、リアクトルLには磁気エネルギーが蓄えられる。FETがオフ状態になると、その期間にリアクトルLに蓄えられた磁気エネルギーがダイオードDを通して放出され、この放出エネルギーでコンデンサCが充電されてコンデンサCの両端に現れる電圧が予め定めた電圧まで昇圧される。直流電圧変換回路3の出力電圧は一定に維持される。

【0015】制御信号発生回路5は、FETのスイッチング周期を固定して電流指令I(n)に応じてオン時間を制御するPWM方式によりFETのゲート信号を変化させる。その結果、軽負荷になると、リアクトルLの電流がゼロに近づき、負荷が重くなるとリアクトルLを流れる電流が大きくなる。制御信号発生回路5は、電流指令I(n)に応じて、FETのオン時間を変化させるPWM制御信号を発生するPWM制御回路11と、PWM制御信号を入力としてFETのゲート信号を出力するドライブ回路13と、人力直流発電機1の出力電圧を入力として電流指令を出力する電流指令発生手段15とから構成されている。

【0016】電流指令発生手段15は、人力直流発電機1の出力電圧V_gが予め定めた第1の設定電圧V₁未満の低電圧範囲にあるときには、出力電流を0にするか又は人力直流発電機1を動かす人間(運転者)に実質的に負荷を与えない値にする電流指令I(n)を出力し、出力電圧が第1の設定電圧V₁以上で第1の設定電圧V₁よりも高い第2の設定電圧V₂以下の中間電圧範囲にあるときには、出力電圧V_gの増減に応じて出力電流I_gを増減させる電流指令I(n)を出力し、出力電圧V_gが第2の設定電圧V₂より大きくなる高電圧範囲にあるときには、出力電流I_gを予め定めた値に制限する電流指令を出力するように構成されている。

【0017】具体的には、電流指令発生手段15は、電圧範囲判定手段17と電流指令決定出力手段19とから構成される。本実施の形態では、電流指令発生手段15の主要部をマイクロコンピュータを用いて実現している。電圧範囲判定手段17は、人力直流発電機1の出力電圧V_gが低電圧範囲、中間電圧範囲及び高電圧範囲のいずれの電圧範囲にあるのかを判定する。例えば、電圧範囲判定手段17は、出力電圧V_gをデジタル値に変換するA-D変換器と、第1及び第2の設定電圧V₁及び

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V₂をデジタル値として記憶して保持する設定電圧記憶保持回路と、電圧範囲を判定する判定回路とから構成することができる。

【0018】また電流指令決定出力手段19は、電圧範囲判定手段17の判定結果により、人力直流発電機1の出力電圧V_gが低電圧範囲にあるときには、出力電流I_gを0にするか又は人力直流発電機1を動かす人間に実質的に負荷を与えない値にする電流指令I(n)を出力し、出力電圧V_gが中間電圧範囲にあるときには、出力電圧V_gの増減に応じて出力電流I_gを増減させるように予め定めた演算式または予め定めた人力直流発電機1の出力電圧と出力電流との関係を定めたデータに基づいて電流指令I(n)を出力し、出力電圧V_gが高電圧範囲にあるときには、出力電流I_gを予め定めた値に制限する電流指令I(n)を出力するように構成されている。

【0019】図1において、蓄電池回路7は蓄電池Bから構成され、この蓄電池Bは、直流電圧変換回路3の出力で充電される。なおこの実施の形態では、蓄電池Bを出力制御装置2の電源として用いている。この蓄電池は、僅かではあるが、人力発電の不足分をバックアップする。

【0020】図2は、図1の実施の形態の電流指令決定出力手段19内で用いる予め定めた人力直流発電機1の出力電圧と出力電流(電流指令)との関係を定めたデータ(またはマップ)の一例である。このデータに従えば、電流指令発生手段15は、人力直流発電機1の出力電圧V_gが予め定めた第1の設定電圧V₁未満の低電圧範囲(aまでの範囲)にあるときには、出力電流を0にするか又は人力直流発電機1を動かす人間に実質的に負荷を与えない値I₁にする電流指令(電流指令の初期値I(0))を出力する。また電流指令発生手段15は、出力電圧V_gが第1の設定電圧V₁以上で第1の設定電圧V₁よりも高い第2の設定電圧V₂以下の中間電圧範囲(abの範囲)にあるときには、出力電圧V_gの増減に応じて出力電流を直線的に増減させる電流指令を出力する。そして電流指令発生手段15は、出力電圧V_gが第2の設定電圧V₂より大きくなる高電圧範囲(bcの範囲)にあるときには、出力電流を予め定めた値I₂に制限する。この電圧値V₂及び電流値I₂は、負荷9の定格電力に基いて定める。なお出力電圧V_gが図中のc点に達すると、図示しない過電圧防止回路が動作して、蓄電池Bや負荷9を過電圧から保護する。

【0021】この例では、中間電圧範囲において電流指令は、直線的に変化しているが、中間電圧範囲の特性は、人力への負担やその他の観点より考慮して非直線的に変化させるようにしてもよい。またこのようなデータまたはマップを用いずに、予め定めた演算式に基づいて必要な電流指令を出力するようにしてもよい。

【0022】図3は、本発明の他の実施の形態で用いる電流指令発生手段15の主要部をマイクロコンピュータ

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を用いて実現する場合に用いるソフトウェアのアルゴリズムを示すフローチャートの一例である。この例では、前回の電流指令と今回の電流指令とを平均した電流指令を出力する電流指令平均化手段を電流指令発生手段15内に実現する。またこの例では、人力直流発電機1の出力電圧が、ある程度安定するまでの時間が経過するまでは、実際の制御を行わないようにしている。

【0023】まず、人力直流発電機1が人力により回転させられて発電が開始されると、ステップST1において発電を開始してから予め定めた時間（図では1秒間）が経過するまで判定動作を行わないように構成されている。これによって発電開始時の不安定な回転に伴う不安定な発電における判定動作を避けている。この時間が経過した後、ステップST2に進む。ステップST2においては、電流指令発生手段内の所定のレジスタに電流指令の初期値 $I(0)$ が格納される。この初期値 $I(0)$ は、出力電流を0にするか又は人力直流発電機を動かす人間に実質的に負荷を与えない値 $I1$ 以内にする電流指令である（ $0 \leq I(0) \leq I1$ ）。格納の後、次のステップST3に進む。ステップST3においては、人力直流発電機1の出力電圧 Vg に対応する電流指令を所定の時間周期で決定するために、この時間周期をステップST3で実現している。図の例ではこの時間周期を100msとしている。所定の時間（100ms）経過の後、ステップST4に進み、人力直流発電機1の出力電圧 Vg をその時刻の値 $Vg(n)$ として読みとる。次にステップST5に進み、読み取った出力電圧 $Vg(n)$ を予め定めた第1の設定電圧 $V1$ と比較する。比較判定の結果、出力電圧 $Vg(n)$ が第1の設定電圧 $V1$ 以上と判定されればステップST6に進み、 $V1$ 未満の低電圧範囲と判定されればステップST9に進む。出力電圧 Vg が第1の設定電圧 $V1$ 以上の場合には、ステップST6で出力電圧 $Vg(n)$ を予め定めた第2の設定電圧 $V2$ と比較する。比較判定の結果、出力電圧 $Vg(n)$ が第2の設定電圧 $V2$ 以下の中間電圧範囲と判定されればステップST7に進み、第2の設定電圧 $V2$ を超える高電圧範囲と判定されればステップST8へと進む。

【0024】中間電圧範囲と判定されてステップST7に進むと、電流指令は図2のab間の比例関係より、 $I(m) = I2 - k(V2 - Vg(n))$ として求められる。ここで k は比例係数で、正の有理数である。一方高電圧範囲と判定されたステップST8において、電流指令は出力電流を予め定めた値 $I2$ に制限する電流指令を出力するように、 $I(m) = I2$ として求められる。また低電圧範囲と判定されてステップST9に進むと、電流指令は出力電流を0にするか又は人力直流発電機を動かす人間に実質的に負荷を与えない値にする電流指令として、 $I(m) = I(0)$ （但し $0 \leq I(0) \leq I1$ ）として決定される。これらステップST7～9において電流指令 $I(m)$ が求まり、次のステップST10に進む。ステップST10におい

ては、前回の電流指令 $I(n-1)$ と今回求めた電流指令 $I(m)$ との算術平均によって新しい電流指令 $I(n)$ を演算する。前回の電流指令 $I(n-1)$ は電流指令発生手段内の所定のレジスタに格納されているので、それを用いればよい。発電開始の場合でも、電流指令発生手段内の所定のレジスタにステップST1において電流指令の初期値 $I(0)$ が格納されている。得られた新しい電流指令 $I(n)$ は、出力制御装置5の中のPWM制御回路11に送られて直流電圧変換回路3の出力電流を制御するようにドライブ回路13を介して直流電圧変換回路3のFETを駆動する。更にこのステップST10において、今演算で求めた新しい電流指令 $I(n)$ を次のために電流指令発生手段内の所定のレジスタに $I(n-1)$ として格納して次のステップST11に進む。ステップST11において、発電の運転終了を判定する。判定の結果、終了であれば終了し、終了でなければステップST3に戻って所定の時間経過を待ち、次の周期で人力直流発電機1の出力電圧 Vg をその時刻の値 $Vg(n)$ として対応する次の電流指令 $I(n)$ を求めるプロセスに入る。

【0025】本発明においては上述のように、人力直流発電機の出力電圧の範囲（低電圧範囲、中間電圧範囲、高電圧範囲）に見合った電流指令を出力することにより、運転始動時における人体への過大な負荷を軽減して、円滑な発電を可能とすることができる。

【0026】

【発明の効果】本発明によれば、人力発電機の出力がある程度安定するまでは、負荷に電力が供給されないのて、運転者は無理無く人力発電機の出力電圧を増大させていくことができる。そして出力電圧がある程度安定した状態になった後に、出力電流を負荷に流すようにすると、人力発電機の回転部の慣性力が大きくなっているために、負荷に比較的大きな電流を流したとしても、運転者の負担が極端に大きくなることはなく、必要な電力を負荷に供給しながら、滑らかに出力を増減することができる利点がある。また本発明においては、出力電圧が予め定めた上限電圧を超えると、出力電流の増加を制限するため、運転者に過剰な負荷がかかって脱調状態になるのを防止できただけでなく、負荷に過電流が流れるのを防止することができる利点がある。

【図面の簡単な説明】

【図1】本発明の人力発電装置の実施形態の一例を示す回路図である。

【図2】図1の実施の形態で用いる電流指令と発電機出力電圧 Vg との関係を示す図である。

【図3】本発明の他の実施の形態で用いる制御用のソフトウェアのアルゴリズムを示すフローチャートの一例である。

【符号の説明】

1 人力直流発電機

2 出力制御装置

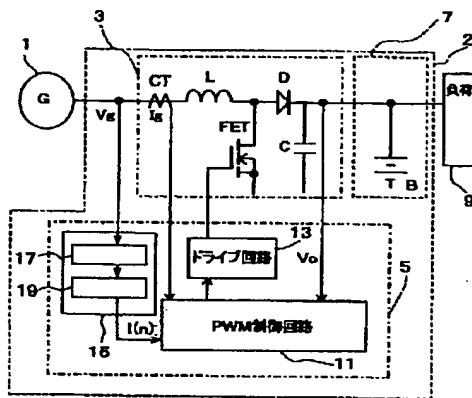
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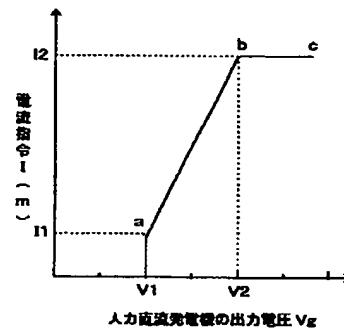
- 3 直流電圧変換回路
- 5 制御信号発生回路
- 7 蓄電池回路
- 9 負荷
- 11 PWM制御回路
- 13 ドライブ回路
- 15 電流指令発生手段

- 17 電圧範囲判定手段
- 19 電流指令決定出力手段
- B 蓄電池
- C コンデンサ
- CT 電流検出器
- D ダイオード
- L リアクトル

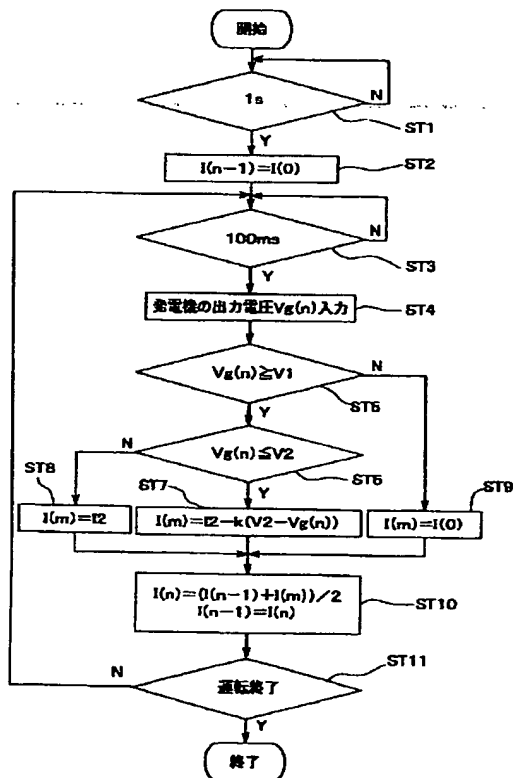
【図1】



【図2】



【図3】



フロントページの続き

(72)発明者 小林 康彦

東京都豊島区北大塚一丁目15番1号 山洋
電気株式会社内

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*** NOTICES ***

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CLAIMS

[Claim(s)]

[Claim 1] It is the human power power plant equipped with the human power generator generated by human power, and the power control device which controls the output current of said human power generator. Until the output voltage of said power control device of said human power generator is stable The output current for said load so that the output current may fluctuate in proportion to the change in said output voltage, after not passing the output current for a load substantially but stabilizing said output voltage A sink, The human power power plant characterized by being constituted so that the increment in said output current may be restricted, if said output voltage exceeds the upper limit electrical potential difference defined beforehand.

[Claim 2] The human power direct current generator which generates direct current power by human power, It is the human power power plant equipped with the power control device which has a current command generating means to consider pressure up or the direct-current-voltage conversion circuit whose pressure is lowered, and said output voltage as an input for said output voltage according to a current command, and to output said current command in order to control the output current of said human power direct current generator. When said output voltage of said human power direct current generator is in the low-battery range under of the 1st programmed voltage defined beforehand, said current command generating means The current command made into the value which does not give a load substantially to human being who sets said output current to 0, or moves said human power direct current generator is outputted. When said output voltage is in the intermediate voltage range below the 2nd programmed voltage higher than said 1st programmed voltage above said 1st programmed voltage When it is in the high-tension range in which the current command which makes said output current fluctuate according to the change in said output voltage is outputted, and said output voltage becomes large from said 2nd programmed voltage The human power power plant characterized by being constituted so that the current command which restricts said output current to the value defined beforehand may be outputted.

[Claim 3] Whether said current command generating means has said output

voltage in which electrical-potential-difference range of said low-battery range, said intermediate voltage range, and said high-tension range by the judgment result of an electrical-potential-difference range judging means to judge, and said electrical-potential-difference range judging means When said output voltage of said human power direct current generator is in said low-battery range When the current command made into the value which does not give a load substantially to human being who sets said output current to 0, or moves said human power direct current generator is outputted and said output voltage is in said intermediate voltage range A current command is outputted based on the data which defined the relation between the output voltage of the operation expression set beforehand that said output current is made to fluctuate according to the change in said output voltage, or the human power d-c generator defined beforehand, and the output current. The human power power plant according to claim 2 characterized by consisting of current command decision output means to output the current command which restricts said output current to the value defined beforehand when said output voltage is in said high-tension range.

[Claim 4] Said electrical-potential-difference range judging means is a human power power plant according to claim 3 constituted so that judgment actuation may not be performed until the time amount defined beforehand passes, after starting a generation of electrical energy.

[Claim 5] It is the human power power plant according to claim 2 which is equipped with the battery charged with the output of said direct-current-voltage conversion circuit, and is constituted so that said power control device may operate considering said battery as a power source.

[Claim 6] Said current command decision output means is a human power power plant according to claim 3 which opts for a current command and is characterized by having further a current command equalization means to output the current command which averaged the determined last current command and this current command with a predetermined period.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the human power power plant generated by human power.

[0002]

[Description of the Prior Art] In the human power power plant using the conventional human power, when a human power generator is driven by human power, control which makes regularity a load electrical potential difference and a current is performed. Especially a problem is not produced when such control of a load is also small.

[0003]

[Problem(s) to be Solved by the Invention] However, when the load became beyond about 100W, even if it was a step-type human power generator, when it was going to supply power to the load from the beginning, a load becomes heavy and an operator's burden became large too much, it becomes impossible to have carried out the smooth generation of electrical energy, and when the worst, there was a problem will be in a power swing condition and it becomes impossible to perform smooth generation-of-electrical-energy actuation.

[0004] the object of this invention is to offer the human power power plant which can come out and perform generating electricity smoothly, even when a load becomes large.

[0005] Other objects of this invention are to mitigate an operator's load in the time of a generation of electrical energy, and offer the power plant which enables a smooth generation of electrical energy.

[0006]

[Means for Solving the Problem] Let this invention be the object of amelioration of the human power power plant equipped with the human power generator generated by human power, and the power control device which controls the output current of a human power generator. In this invention, the output current is not substantially passed for a load, but if the upper limit electrical potential difference to which a sink and output voltage set the output current beforehand that the output current fluctuates in proportion to the change in output voltage to the load is exceeded after stabilizing output voltage, it constitutes so that the increment in the output current may be restricted, until the output voltage of a human power generator is stabilized in a power control device. Since power will not be supplied to a load until the output of a human power generator is stabilized to some extent if it does in this way, an operator can increase the rotational frequency of a human power generator reasonable. An output can be fluctuated smoothly, there being nothing it becomes large [an operator's burden] extremely [things] even if it passes a current for a comparatively big load, since the inertia force of the revolution section of a human power generator is large, if the output current is passed for a load after output voltage is stabilized to some extent and to become, and supplying required power to a load. Moreover, in this invention, if output voltage exceeds the upper limit electrical potential difference defined beforehand, since the increment in the output current will be restricted, it can prevent that can prevent that a superfluous load is applied to an operator and it will be in a power swing condition, and an overcurrent flows not for **** but for a load.

[0007] If it sees on more concrete level, in order to control by human power the output current of the human power direct current generator which generates direct current power, and a human power direct current generator, let this invention be the object of amelioration of the human power power plant equipped with the power control device which has a current command generating means to consider pressure up or the direct-current-voltage conversion circuit whose pressure is lowered, and output voltage as an input for output voltage according to a current command, and to output a current command. in this case, when the output voltage of a human power direct current generator is in the low-battery range (initial condition of a generation of electrical energy) under of the 1st programmed voltage defined beforehand, a current command generating means The current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator is outputted. When output voltage is in the intermediate voltage range below the 2nd programmed voltage higher than the 1st programmed voltage above said 1st programmed voltage The current command which makes the output current fluctuate according to the change in output voltage is outputted, and when it is in the high-tension range in which output voltage becomes large from the 2nd programmed voltage (it sets near the rated voltage of a load as an example), it constitutes so that the current command which restricts the output current to the value defined beforehand may be outputted. If it does in this way, a current

command generating means can be constituted easily.

[0008] Whether a current command generating means has the output voltage of a human power direct current generator in which electrical-potential-difference range of the low-battery range, the intermediate voltage range, and the high-tension range by moreover, the judgment result of an electrical-potential-difference range judging means to judge, and an electrical-potential-difference range judging means When the output voltage of a human power direct current generator is in the low-battery range When the current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator is outputted and output voltage is in the intermediate voltage range A current command is outputted based on the data which defined the relation between the operation expression set beforehand that the output current is made to fluctuate according to the change in output voltage or the output voltage defined beforehand, and the output current. When output voltage is in the high-tension range, it can constitute from a current command decision output means to output the current command which restricts the output current to the value defined beforehand. Thus, if the configuration which outputs a current command based on the data which defined the relation between the operation expression beforehand determined as the electrical-potential-difference range or the output voltage defined beforehand, and the output current is adopted, the output current is controllable by higher precision.

[0009] In addition, when the output voltage of a human power direct current generator is in the intermediate voltage range, although you may determine that it increases linearly to the increment in an electrical potential difference, it is natural [the current command which makes the output current fluctuate according to the change in output voltage] that it takes into consideration from the burden to people or other viewpoints, and you may make it make it increase in nonlinear.

[0010] In addition, an electrical-potential-difference range judging means is constituted so that judgment actuation may not be performed, until the time amount defined beforehand passes, after starting a generation of electrical energy. Since judgment actuation will not be performed until output voltage is stabilized at the time of generation-of-electrical-energy initiation if it does in this way, the judgment precision of the electrical-potential-difference range and the reliability of a judgment can be raised.

[0011] Moreover, the battery charged with the output of a direct-current-voltage conversion circuit can be formed, and a power control device can be constituted so that it may operate considering this battery as a power source. If a battery is used as the power source of a power control device, even if it is in the condition that the input voltage of a direct-current-voltage conversion circuit is low, since a power control device operates correctly, it can prevent malfunction which it becomes a cause that the power source of a power control device is instability, and is generated. In addition, although this battery is few, it is contributed to the electric power supply to a load.

[0012] Moreover, as for the above-mentioned current command decision output means, it is desirable to have further a current command equalization means to output the current command which averaged the last current command which opted for the current command and was determined, and this current command, with the predetermined period. Since it will be equalized even if the output power of a human power direct current generator may fluctuate temporarily if such a current equalization means is established, it can prevent changing the output power to a

load sharply, and the overload applied to an operator's body as a result can also be controlled. The equalization technique of a current command equalization means can include the equalization technique other than the simple arithmetic mean, such as a weighted average, here.

[0013]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing. Drawing 1 is the circuit diagram showing an example of the operation gestalt of the human power power plant of this invention. In drawing 1, the members shown with the sign 1 are human power direct current generators, such as a preparation using human power, or a step type, and the part shown with the sign 2 is a power control device which controls the output current of this human power direct current generator 1. After this power control device 2 did not pass the output current for a load 9 substantially but its output voltage was stable, it outputs a current to a load 9 so that the output current may fluctuate in proportion to the change in output voltage, and if output voltage exceeds the upper limit electrical potential difference defined beforehand, it is constituted so that the increment in the output current may be restricted, until the output voltage of the human power direct current generator 1 is stabilized. What is necessary is just to arrange a rectifier circuit to the output side of a human power generator as a human power generator, as a human power generator, with the gestalt of this operation, in using an AC generator although the human power direct current generator 1 is used.

[0014] The power control device 2 is equipped with the control signal generating circuit 5 which outputs the control signal which is constituted including a current command generating means 15 to output a current command by considering the direct-current-voltage conversion circuit 3 which carries out pressure up of the output voltage of the human power direct current generator 1, and output voltage of the human power direct current generator 1 as an input, and controls the direct-current-voltage conversion circuit 3, and the battery circuit 7 equipped with Battery B. The direct-current-voltage conversion circuit 3 of this example is a pressure-up mold direct-current-voltage conversion circuit constituted by the switching regulator called the so-called DC-DC converter. This direct-current-voltage conversion circuit 3 consists of capacitors C connected with the cathode, the field-effect transistor, i.e., FET, by which the drain was connected to the other end of the diode D by which the anode was connected to the other end of the current detector CT 1 which detects the current I_g which flows to the reactor L by which the end was connected to the outgoing end of the human-power direct current generator 1, and this reactor L, and Reactor L, and Reactor L, and the source was connected to the ground, of Diode D between grounds. The output of the drive circuit 13 later mentioned in the control signal generating circuit 5 is inputted into the gate of FET. In this direct-current-voltage conversion circuit 3, when FET is in an ON state, to Reactor L, a current flows through FET, and magnetic energy is stored in Reactor L. If FET is turned off, the magnetic energy stored in Reactor L will be emitted to that period through Diode D, and pressure up of the electrical potential difference which Capacitor C is charged with this bleedoff energy, and appears in the ends of Capacitor C will be carried out to the electrical potential difference defined beforehand. The output voltage of the direct-current-voltage conversion circuit 3 is maintained uniformly.

[0015] The control signal generating circuit 5 changes the gate signal of FET by the PWM which fixes the switching period of FET and controls ON time amount

according to current command $I(n)$. Consequently, if it becomes a light load, the current of Reactor L will approach zero, and if a load becomes heavy, the current which flows Reactor L will become large. The control signal generating circuit 5 consists of an PWM control circuit 11 which generates the PWM control signal to which the ON time amount of FET is changed, a drive circuit 13 which outputs the gate signal of FET by considering an PWM control signal as an input, and a current command generating means 15 to output a current command by considering output voltage of the human power direct current generator 1 as an input, according to current command $I(n)$.

[0016] When the output voltage V_g of the human power direct current generator 1 is in the 1st low-battery range below programmed-voltage V_1 defined beforehand, the current command generating means 15 Current command $I(n)$ made into the value which does not give a load substantially to human being (operator) who sets the output current to 0 or moves the human power direct current generator 1 is outputted. When it is in the 2nd intermediate voltage range not more than programmed-voltage V_2 more than at the 1st programmed-voltage V_1 where output voltage is higher than the 1st programmed voltage V_1 Current command $I(n)$ which makes the output current I_g fluctuate according to the change in output voltage V_g is outputted, and when it is in the high-tension range in which output voltage V_g becomes large from the 2nd programmed voltage V_2 , it is constituted so that the current command which restricts the output current I_g to the value defined beforehand may be outputted.

[0017] Specifically, the current command generating means 15 consists of an electrical-potential-difference range judging means 17 and a current command decision output means 19. With the gestalt of this operation, the body of the current command generating means 15 is realized using a microcomputer. It judges whether the electrical-potential-difference range judging means 17 has the output voltage V_g of the human power direct current generator 1 in which electrical-potential-difference range of the low-battery range, the intermediate voltage range, and the high-tension range. For example, the electrical-potential-difference range judging means 17 can consist of an A-D converter which changes output voltage V_g into digital value, a programmed-voltage storage holding circuit which memorizes the 1st and 2nd programmed voltages V_1 and V_2 as digital value, and holds them, and a judgment circuit which judges the electrical-potential-difference range.

[0018] moreover, by the judgment result of the electrical-potential-difference range judging means 17, when the output voltage V_g of the human power direct current generator 1 is in the low-battery range, the current command decision output means 19 When current command $I(n)$ made into the value which does not give a load substantially to human being who sets the output current I_g to 0, or moves the human power direct current generator 1 is outputted and output voltage V_g is in the intermediate voltage range Current command $I(n)$ is outputted based on the data which defined the relation between the output voltage of the operation expression set beforehand that the output current I_g is made to fluctuate according to the change in output voltage V_g , or the human power d-c generator 1 defined beforehand, and the output current. When output voltage V_g is in the high-tension range, it is constituted so that current command $I(n)$ which restricts the output current I_g to the value defined beforehand may be outputted.

[0019] In drawing 1, the battery circuit 7 consists of batteries B, and this battery B is charged with the output of the direct-current-voltage conversion circuit 3. In

addition, with the gestalt of this operation, Battery B is used as a power source of a power control device 2. Although this battery is few, it backs up the insufficiency of a human power generation of electrical energy.

[0020] Drawing 2 is an example of data (or map) which defined the relation between the output voltage of the human power d-c generator 1 which is used within the current command decision output means 19 of the gestalt of operation of drawing 1, and which was defined beforehand, and the output current (current command). If this data is followed, the current command generating means 15 will output the current command (initial value [of a current command] I (0)) made into the value I1 which does not give a load substantially to human being who sets the output current to 0 or moves the human power direct current generator 1, when the output voltage Vg of the human power direct current generator 1 is in the 1st low-battery range below programmed-voltage V1 (range to a) defined beforehand. Moreover, the current command generating means 15 outputs the current command which makes the output current fluctuate linearly according to the change in output voltage Vg, when it is in the 2nd intermediate voltage range not more than programmed-voltage V2 more than at the 1st programmed-voltage V1 (the range of ab) where output voltage Vg is higher than the 1st programmed voltage V1. And the current command generating means 15 is restricted to the value I2 which defined the output current beforehand, when it is in the high-tension range (the range of bc) in which output voltage Vg becomes larger than the 2nd programmed voltage V2. This electrical-potential-difference value V2 and current value I2 are defined based on the rated power of a load 9. In addition, if output voltage Vg reaches c points of drawing, the overvoltage prevention circuit which is not illustrated will operate and Battery B and a load 9 will be protected from an overvoltage.

[0021] Although the current command is changing linearly in the intermediate voltage range, the property of the intermediate voltage range is taken into consideration from the burden to human power, or other viewpoints, and you may make it change it in nonlinear in this example. Moreover, you may make it output a required current command based on the operation expression defined beforehand, without using such data or a map.

[0022] Drawing 3 is an example of the flow chart which shows the algorithm of the software used when realizing the body of the current command generating means 15 used with the gestalt of other operations of this invention using a microcomputer. In this example, a current command equalization means to output the current command which averaged the last current command and this current command is realized in the current command generating means 15. Moreover, in this example, it is made not to perform actual control until time amount until the output voltage of the human power direct current generator 1 is stabilized to some extent passes.

[0023] First, if the human power direct current generator 1 is rotated by human power and a generation of electrical energy is started, it is constituted so that judgment actuation may not be performed, until the time amount (drawing for 1 second) defined beforehand passes, after starting a generation of electrical energy in a step ST 1. The judgment actuation in the unstable generation of electrical energy accompanying the unstable revolution at the time of generation-of-electrical-energy initiation is avoided by this. After this time amount passes, it progresses to a step ST 2. In a step ST 2, initial value [of a current command] I (0) is stored in the predetermined register within a current command generating

means. This initial value $I(0)$ is a current command made into less than [value $I1$] does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator ($0 \leq I(0) \leq I1$). It progresses to the following step ST 3 after storing. In a step ST 3, in order to opt for the current command corresponding to the output voltage V_g of the human power direct current generator 1 by the predetermined time period, this time period is realized at a step ST 3. This time period is set to 100ms in the example of drawing. It progresses to a step ST 4 after predetermined time amount (100ms) progress, and the output voltage V_g of the human power direct current generator 1 is read as a value V_g of the time of day (n). Next, it compares with the 1st programmed voltage $V1$ which set beforehand the output voltage V_g (n) progressed and read to a step ST 5. As a result of a comparison test, if output voltage V_g (n) is judged more than as the 1st programmed-voltage $V1$, it will progress to a step ST 6, and if judged with the low-battery range below $V1$, it will progress to a step ST 9. When output voltage V_g is more than the 1st programmed-voltage $V1$, it compares with the 2nd programmed voltage $V2$ which defined output voltage V_g (n) beforehand at a step ST 6. As a result of a comparison test, if output voltage V_g (n) is judged to be the 2nd intermediate voltage range not more than programmed-voltage $V2$, it will progress to a step ST 7, and if judged with the high-tension range exceeding the 2nd programmed voltage $V2$, it will progress to a step ST 8.

[0024] If it is judged with the intermediate voltage range and progresses to a step ST 7, a current command will be called for as $I(m) = I2 - k(V2 - V_g(n))$ from the proportionality between $ab(s)$ of drawing 2. k is a proportionality coefficient and is a forward rational number here. In the step ST 8 judged on the other hand to be the high-tension range, a current command is called for as $I(m) = I2$ so that the current command restricted to the value $I2$ which defined the output current beforehand may be outputted. Moreover, if it is judged with the low-battery range and progresses to a step ST 9, it will opt for a current command as $I(m) = I(0)$ (however, $0 \leq I(0) \leq I1$) as a current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator. Current command $I(m)$ can be found in these steps 7-STs 9, and it progresses to the following step ST 10. In a step ST 10, new current command $I(n)$ is calculated by the arithmetic mean of the last current command $I(n-1)$ and current command [for which it asked this time] $I(m)$. What is necessary is just to use it, since the last current command $I(n-1)$ is stored in the predetermined register within a current command generating means. Also in the case of generation-of-electrical-energy initiation, in a step ST 1, initial value [of a current command] $I(0)$ is stored in the predetermined register within a current command generating means. Obtained new current command $I(n)$ drives FET of the direct-current-voltage conversion circuit 3 through the drive circuit 13 so that it may be sent to the PWM control circuit 11 in a power control device 5 and the output current of the direct-current-voltage conversion circuit 3 may be controlled. Furthermore, in this step ST 10, new current command $I(n)$ for which it asked by the operation now is stored in the predetermined register within a current command generating means as $I(n-1)$ for next time, and it progresses to the following step ST 11. In a step ST 11, operation termination of a generation of electrical energy is judged. As a result of a judgment, it will end, if it is termination, and if it is not termination, it will go into the process which asks for next current command $I(n)$ which returns to a step ST 3 and corresponds predetermined time amount progress with waiting and the following period considering the output

voltage V_g of the human power direct current generator 1 as a value V_g of the time of day (n).

[0025] In this invention, as mentioned above, by outputting the current command corresponding to the range of the output voltage of a human power direct current generator (the low-battery range, intermediate voltage range, high-tension range), the excessive load to the body at the time of operation start up can be mitigated, and a smooth generation of electrical energy can be enabled.

[0026]

[Effect of the Invention] Since according to this invention power is not supplied to a load until the output of a human power generator is stabilized to some extent, an operator can increase the output voltage of a human power generator reasonable. And even if it will pass a comparatively big current for a load since the inertia force of the revolution section of a human power generator is large if the output current is passed for a load after being stabilized to some extent by output voltage, the thing to which an operator's burden becomes extremely large and to become has the advantage which can fluctuate an output smoothly, there being nothing and supplying required power to a load. Moreover, if output voltage exceeds the upper limit electrical potential difference defined beforehand in this invention, in order to restrict the increment in the output current, there is an advantage which can prevent that can prevent that a superfluous load is applied to an operator and it will be in a power swing condition, and an overcurrent flows not for **** but for a load.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the human power power plant generated by human power.

PRIOR ART

[Description of the Prior Art] In the human power power plant using the conventional human power, when a human power generator is driven by human power, control which makes regularity a load electrical potential difference and a current is performed. Especially a problem is not produced when such control of a load is also small.

EFFECT OF THE INVENTION

[Effect of the Invention] Since according to this invention power is not supplied to a load until the output of a human power generator is stabilized to some extent, an operator can increase the output voltage of a human power generator reasonable. And even if it will pass a comparatively big current for a load since the inertia force of the revolution section of a human power generator is large if the output current is passed for a load after being stabilized to some extent by output voltage, the thing to which an operator's burden becomes extremely large and to become has the advantage which can fluctuate an output smoothly, there being nothing and supplying required power to a load. Moreover, if output voltage exceeds the upper limit electrical potential difference defined beforehand in this invention, in order to restrict the increment in the output current, there is an advantage which can prevent that can prevent that a superfluous load is applied to an operator and it will be in a power swing condition, and an overcurrent flows not for **** but for a load.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when the load became beyond about 100W, even if it was a step-type human power generator, when it was going to supply power to the load from the beginning, a load becomes heavy and an operator's burden became large too much, it becomes impossible to have carried out the smooth generation of electrical energy, and when the worst, there was a problem will be in a power swing condition and it becomes impossible to perform smooth generation-of-electrical-energy actuation.

[0004] the object of this invention is to offer the human power power plant which can come out and perform generating electricity smoothly, even when a load becomes large.

[0005] Other objects of this invention are to mitigate an operator's load in the time of a generation of electrical energy, and offer the power plant which enables a smooth generation of electrical energy.

MEANS

[Means for Solving the Problem] Let this invention be the object of amelioration of the human power power plant equipped with the human power generator generated by human power, and the power control device which controls the output current of a human power generator. In this invention, the output current is not substantially passed for a load, but if the upper limit electrical potential difference to which a sink and output voltage set the output current beforehand that the output current fluctuates in proportion to the change in output voltage to the load is exceeded after stabilizing output voltage, it constitutes so that the increment in the output current may be restricted, until the output voltage of a human power generator is stabilized in a power control device. Since power will not be supplied to a load until the output of a human power generator is stabilized to some extent if it does in this way, an operator can increase the rotational frequency of a human power generator reasonable. An output can be fluctuated smoothly, there being nothing it becomes large [an operator's burden] extremely [things] even if it passes a current for a comparatively big load, since the inertia force of the revolution section of a human power generator is large, if the output current is passed for a load after output voltage is stabilized to some extent and to become, and supplying required power to a load. Moreover, in this invention, if output voltage exceeds the upper limit electrical potential difference defined beforehand, since the increment in the output current will be restricted, it can prevent that can prevent that a superfluous load is applied to an operator and it will be in a power swing condition, and an overcurrent flows not for **** but for a load.

[0007] If it sees on more concrete level, in order to control by human power the output current of the human power direct current generator which generates direct current power, and a human power direct current generator, let this invention be the object of amelioration of the human power power plant equipped with the power control device which has a current command generating means to consider pressure up or the direct-current-voltage conversion circuit whose pressure is lowered, and output voltage as an input for output voltage according to a current command, and to output a current command. in this case, when the output voltage of a human power direct current generator is in the low-battery range (initial

condition of a generation of electrical energy) under of the 1st programmed voltage defined beforehand, a current command generating means The current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator is outputted. When output voltage is in the intermediate voltage range below the 2nd programmed voltage higher than the 1st programmed voltage above said 1st programmed voltage The current command which makes the output current fluctuate according to the change in output voltage is outputted, and when it is in the high-tension range in which output voltage becomes large from the 2nd programmed voltage (it sets near the rated voltage of a load as an example), it constitutes so that the current command which restricts the output current to the value defined beforehand may be outputted. If it does in this way, a current command generating means can be constituted easily.

[0008] Whether a current command generating means has the output voltage of a human power direct current generator in which electrical-potential-difference range of the low-battery range, the intermediate voltage range, and the high-tension range by moreover, the judgment result of an electrical-potential-difference range judging means to judge, and an electrical-potential-difference range judging means When the output voltage of a human power direct current generator is in the low-battery range When the current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator is outputted and output voltage is in the intermediate voltage range A current command is outputted based on the data which defined the relation between the operation expression set beforehand that the output current is made to fluctuate according to the change in output voltage or the output voltage defined beforehand, and the output current. When output voltage is in the high-tension range, it can constitute from a current command decision output means to output the current command which restricts the output current to the value defined beforehand. Thus, if the configuration which outputs a current command based on the data which defined the relation between the operation expression beforehand determined as the electrical-potential-difference range or the output voltage defined beforehand, and the output current is adopted, the output current is controllable by higher precision.

[0009] In addition, when the output voltage of a human power direct current generator is in the intermediate voltage range, although you may determine that it increases linearly to the increment in an electrical potential difference, it is natural [the current command which makes the output current fluctuate according to the change in output voltage] that it takes into consideration from the burden to people or other viewpoints, and you may make it make it increase in nonlinear.

[0010] In addition, an electrical-potential-difference range judging means is constituted so that judgment actuation may not be performed, until the time amount defined beforehand passes, after starting a generation of electrical energy. Since judgment actuation will not be performed until output voltage is stabilized at the time of generation-of-electrical-energy initiation if it does in this way, the judgment precision of the electrical-potential-difference range and the reliability of a judgment can be raised.

[0011] Moreover, the battery charged with the output of a direct-current-voltage conversion circuit can be formed, and a power control device can be constituted so that it may operate considering this battery as a power source. If a battery is used as the power source of a power control device, even if it is in the condition that the

input voltage of a direct-current-voltage conversion circuit is low, since a power control device operates correctly, it can prevent malfunction which it becomes a cause that the power source of a power control device is instability, and is generated. In addition, although this battery is few, it is contributed to the electric power supply to a load.

[0012] Moreover, as for the above-mentioned current command decision output means, it is desirable to have further a current command equalization means to output the current command which averaged the last current command which opted for the current command and was determined, and this current command, with the predetermined period. Since it will be equalized even if the output power of a human power direct current generator may fluctuate temporarily if such a current equalization means is established, it can prevent changing the output power to a load sharply, and the overload applied to an operator's body as a result can also be controlled. The equalization technique of a current command equalization means can include the equalization technique other than the simple arithmetic mean, such as a weighted average, here.

[0013]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing. Drawing 1 is the circuit diagram showing an example of the operation gestalt of the human power power plant of this invention. In drawing 1, the members shown with the sign 1 are human power direct current generators, such as a preparation using human power, or a step type, and the part shown with the sign 2 is a power control device which controls the output current of this human power direct current generator 1. After this power control device 2 did not pass the output current for a load 9 substantially but its output voltage was stable, it outputs a current to a load 9 so that the output current may fluctuate in proportion to the change in output voltage, and if output voltage exceeds the upper limit electrical potential difference defined beforehand, it is constituted so that the increment in the output current may be restricted, until the output voltage of the human power direct current generator 1 is stabilized. What is necessary is just to arrange a rectifier circuit to the output side of a human power generator as a human power generator, as a human power generator, with the gestalt of this operation, in using an AC generator although the human power direct current generator 1 is used.

[0014] The power control device 2 is equipped with the control signal generating circuit 5 which outputs the control signal which is constituted including a current command generating means 15 to output a current command by considering the direct-current-voltage conversion circuit 3 which carries out pressure up of the output voltage of the human power direct current generator 1, and output voltage of the human power direct current generator 1 as an input, and controls the direct-current-voltage conversion circuit 3, and the battery circuit 7 equipped with Battery B. The direct-current-voltage conversion circuit 3 of this example is a pressure-up mold direct-current-voltage conversion circuit constituted by the switching regulator called the so-called DC-DC converter. This direct-current-voltage conversion circuit 3 consists of capacitors C connected with the cathode, the field-effect transistor, i.e., FET, by which the drain was connected to the other end of the diode D by which the anode was connected to the other end of the current detector CT 1 which detects the current I_g which flows to the reactor L by which the end was connected to the outgoing end of the human-power direct current generator 1, and this reactor L, and Reactor L, and Reactor L, and the source was connected to the

ground, of Diode D between grounds. The output of the drive circuit 13 later mentioned in the control signal generating circuit 5 is inputted into the gate of FET. In this direct-current-voltage conversion circuit 3, when FET is in an ON state, to Reactor L, a current flows through FET, and magnetic energy is stored in Reactor L. If FET is turned off, the magnetic energy stored in Reactor L will be emitted to that period through Diode D, and pressure up of the electrical potential difference which Capacitor C is charged with this bleedoff energy, and appears in the ends of Capacitor C will be carried out to the electrical potential difference defined beforehand. The output voltage of the direct-current-voltage conversion circuit 3 is maintained uniformly.

[0015] The control signal generating circuit 5 changes the gate signal of FET by the PWM which fixes the switching period of FET and controls ON time amount according to current command $I(n)$. Consequently, if it becomes a light load, the current of Reactor L will approach zero, and if a load becomes heavy, the current which flows Reactor L will become large. The control signal generating circuit 5 consists of an PWM control circuit 11 which generates the PWM control signal to which the ON time amount of FET is changed, a drive circuit 13 which outputs the gate signal of FET by considering an PWM control signal as an input, and a current command generating means 15 to output a current command by considering output voltage of the human power direct current generator 1 as an input, according to current command $I(n)$.

[0016] When the output voltage V_g of the human power direct current generator 1 is in the 1st low-battery range below programmed-voltage V_1 defined beforehand, the current command generating means 15 Current command $I(n)$ made into the value which does not give a load substantially to human being (operator) who sets the output current to 0 or moves the human power direct current generator 1 is outputted. When it is in the 2nd intermediate voltage range not more than programmed-voltage V_2 more than at the 1st programmed-voltage V_1 where output voltage is higher than the 1st programmed voltage V_1 Current command $I(n)$ which makes the output current I_g fluctuate according to the change in output voltage V_g is outputted, and when it is in the high-tension range in which output voltage V_g becomes large from the 2nd programmed voltage V_2 , it is constituted so that the current command which restricts the output current I_g to the value defined beforehand may be outputted.

[0017] Specifically, the current command generating means 15 consists of an electrical-potential-difference range judging means 17 and a current command decision output means 19. With the gestalt of this operation, the body of the current command generating means 15 is realized using a microcomputer. It judges whether the electrical-potential-difference range judging means 17 has the output voltage V_g of the human power direct current generator 1 in which electrical-potential-difference range of the low-battery range, the intermediate voltage range, and the high-tension range. For example, the electrical-potential-difference range judging means 17 can consist of an A-D converter which changes output voltage V_g into digital value, a programmed-voltage storage holding circuit which memorizes the 1st and 2nd programmed voltages V_1 and V_2 as digital value, and holds them, and a judgment circuit which judges the electrical-potential-difference range.

[0018] moreover, by the judgment result of the electrical-potential-difference range judging means 17, when the output voltage V_g of the human power direct current generator 1 is in the low-battery range, the current command decision output

means 19 When current command $I(n)$ made into the value which does not give a load substantially to human being who sets the output current I_g to 0, or moves the human power direct current generator 1 is outputted and output voltage V_g is in the intermediate voltage range Current command $I(n)$ is outputted based on the data which defined the relation between the output voltage of the operation expression set beforehand that the output current I_g is made to fluctuate according to the change in output voltage V_g , or the human power d-c generator 1 defined beforehand, and the output current. When output voltage V_g is in the high-tension range, it is constituted so that current command $I(n)$ which restricts the output current I_g to the value defined beforehand may be outputted.

[0019] In drawing 1, the battery circuit 7 consists of batteries B, and this battery B is charged with the output of the direct-current-voltage conversion circuit 3. In addition, with the gestalt of this operation, Battery B is used as a power source of a power control device 2. Although this battery is few, it backs up the insufficiency of a human power generation of electrical energy.

[0020] Drawing 2 is an example of data (or map) which defined the relation between the output voltage of the human power d-c generator 1 which is used within the current command decision output means 19 of the gestalt of operation of drawing 1, and which was defined beforehand, and the output current (current command). If this data is followed, the current command generating means 15 will output the current command (initial value [of a current command] $I(0)$) made into the value I_1 which does not give a load substantially to human being who sets the output current to 0 or moves the human power direct current generator 1, when the output voltage V_g of the human power direct current generator 1 is in the 1st low-battery range below programmed-voltage V_1 (range to a) defined beforehand. Moreover, the current command generating means 15 outputs the current command which makes the output current fluctuate linearly according to the change in output voltage V_g , when it is in the 2nd intermediate voltage range not more than programmed-voltage V_2 more than at the 1st programmed-voltage V_1 (the range of ab) where output voltage V_g is higher than the 1st programmed voltage V_1 . And the current command generating means 15 is restricted to the value I_2 which defined the output current beforehand, when it is in the high-tension range (the range of bc) in which output voltage V_g becomes larger than the 2nd programmed voltage V_2 . This electrical-potential-difference value V_2 and current value I_2 are defined based on the rated power of a load 9. In addition, if output voltage V_g reaches c points of drawing, the overvoltage prevention circuit which is not illustrated will operate and Battery B and a load 9 will be protected from an overvoltage.

[0021] Although the current command is changing linearly in the intermediate voltage range, the property of the intermediate voltage range is taken into consideration from the burden to human power, or other viewpoints, and you may make it change it in nonlinear in this example. Moreover, you may make it output a required current command based on the operation expression defined beforehand, without using such data or a map.

[0022] Drawing 3 is an example of the flow chart which shows the algorithm of the software used when realizing the body of the current command generating means 15 used with the gestalt of other operations of this invention using a microcomputer. In this example, a current command equalization means to output the current command which averaged the last current command and this current command is realized in the current command generating means 15. Moreover, in

this example, it is made not to perform actual control until time amount until the output voltage of the human power direct current generator 1 is stabilized to some extent passes.

[0023] First, if the human power direct current generator 1 is rotated by human power and a generation of electrical energy is started, it is constituted so that judgment actuation may not be performed, until the time amount (drawing for 1 second) defined beforehand passes, after starting a generation of electrical energy in a step ST 1. The judgment actuation in the unstable generation of electrical energy accompanying the unstable revolution at the time of generation-of-electrical-energy initiation is avoided by this. After this time amount passes, it progresses to a step ST 2. In a step ST 2, initial value [of a current command] $I(0)$ is stored in the predetermined register within a current command generating means. This initial value $I(0)$ is a current command made into less than [value $I1$] does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator ($0 \leq I(0) \leq I1$). It progresses to the following step ST 3 after storing. In a step ST 3, in order to opt for the current command corresponding to the output voltage V_g of the human power direct current generator 1 by the predetermined time period, this time period is realized at a step ST 3. This time period is set to 100ms in the example of drawing. It progresses to a step ST 4 after predetermined time amount (100ms) progress, and the output voltage V_g of the human power direct current generator 1 is read as a value V_g of the time of day (n). Next, it compares with the 1st programmed voltage $V1$ which set beforehand the output voltage V_g (n) progressed and read to a step ST 5. As a result of a comparison test, if output voltage V_g (n) is judged more than as the 1st programmed-voltage $V1$, it will progress to a step ST 6, and if judged with the low-battery range below $V1$, it will progress to a step ST 9. When output voltage V_g is more than the 1st programmed-voltage $V1$, it compares with the 2nd programmed voltage $V2$ which defined output voltage V_g (n) beforehand at a step ST 6. As a result of a comparison test, if output voltage V_g (n) is judged to be the 2nd intermediate voltage range not more than programmed-voltage $V2$, it will progress to a step ST 7, and if judged with the high-tension range exceeding the 2nd programmed voltage $V2$, it will progress to a step ST 8.

[0024] If it is judged with the intermediate voltage range and progresses to a step ST 7, a current command will be called for as $I(m) = I2 - k(V2 - V_g(n))$ from the proportionality between $ab(s)$ of drawing 2. k is a proportionality coefficient and is a forward rational number here. In the step ST 8 judged on the other hand to be the high-tension range, a current command is called for as $I(m) = I2$ so that the current command restricted to the value $I2$ which defined the output current beforehand may be outputted. Moreover, if it is judged with the low-battery range and progresses to a step ST 9, it will opt for a current command as $I(m) = I(0)$ (however, $0 \leq I(0) \leq I1$) as a current command made into the value which does not give a load substantially to human being who sets the output current to 0 or moves a human power direct current generator. Current command $I(m)$ can be found in these steps 7-STs 9, and it progresses to the following step ST 10. In a step ST 10, new current command $I(n)$ is calculated by the arithmetic mean of the last current command $I(n-1)$ and current command [for which it asked this time] $I(m)$. What is necessary is just to use it, since the last current command $I(n-1)$ is stored in the predetermined register within a current command generating means. Also in the case of generation-of-electrical-energy initiation, in a step ST 1, initial value [of a current command] $I(0)$ is stored in the predetermined register within a

current command generating means. Obtained new current command $I(n)$ drives FET of the direct-current-voltage conversion circuit 3 through the drive circuit 13 so that it may be sent to the PWM control circuit 11 in a power control device 5 and the output current of the direct-current-voltage conversion circuit 3 may be controlled. Furthermore, in this step ST 10, new current command $I(n)$ for which it asked by the operation now is stored in the predetermined register within a current command generating means as $I(n-1)$ for next time, and it progresses to the following step ST 11. In a step ST 11, operation termination of a generation of electrical energy is judged. As a result of a judgment, it will end, if it is termination, and if it is not termination, it will go into the process which asks for next current command $I(n)$ which returns to a step ST 3 and corresponds predetermined time amount progress with waiting and the following period considering the output voltage V_g of the human power direct current generator 1 as a value V_g of the time of day (n) .

[0025] In this invention, as mentioned above, by outputting the current command corresponding to the range of the output voltage of a human power direct current generator (the low-battery range, intermediate voltage range, high-tension range), the excessive load to the body at the time of operation start up can be mitigated, and a smooth generation of electrical energy can be enabled.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the circuit diagram showing an example of the operation gestalt of the human power power plant of this invention.

[Drawing 2] It is drawing showing the relation of the current command and the generator output voltage V_g which are used with the gestalt of operation of drawing 1.

[Drawing 3] It is an example of the flow chart which shows the algorithm of the software for control used with the gestalt of other operations of this invention.

[Description of Notations]

1 Human Power Direct Current Generator

2 Power Control Device

3 Direct-Current-Voltage Conversion Circuit

5 Control Signal Generating Circuit

7 Battery Circuit

9 Load

11 PWM Control Circuit

13 Drive Circuit

15 Current Command Generating Means

17 Electrical-Potential-Difference Range Judging Means

19 Current Command Decision Output Means

B Battery

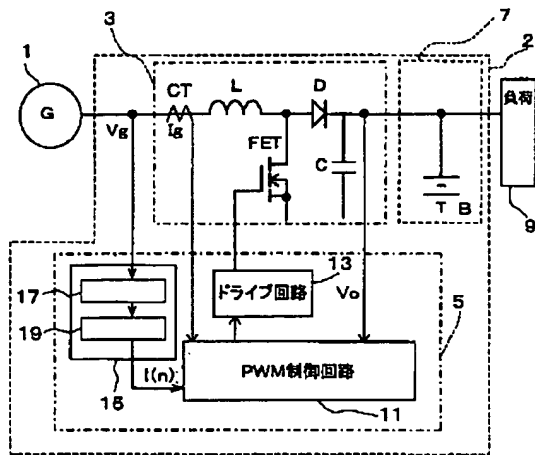
C Capacitor

CT Current detector

D Diode

L Reactor

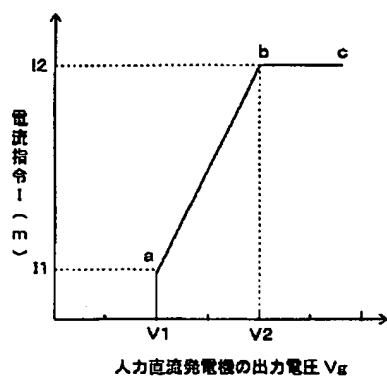
Drawing selection drawing 1



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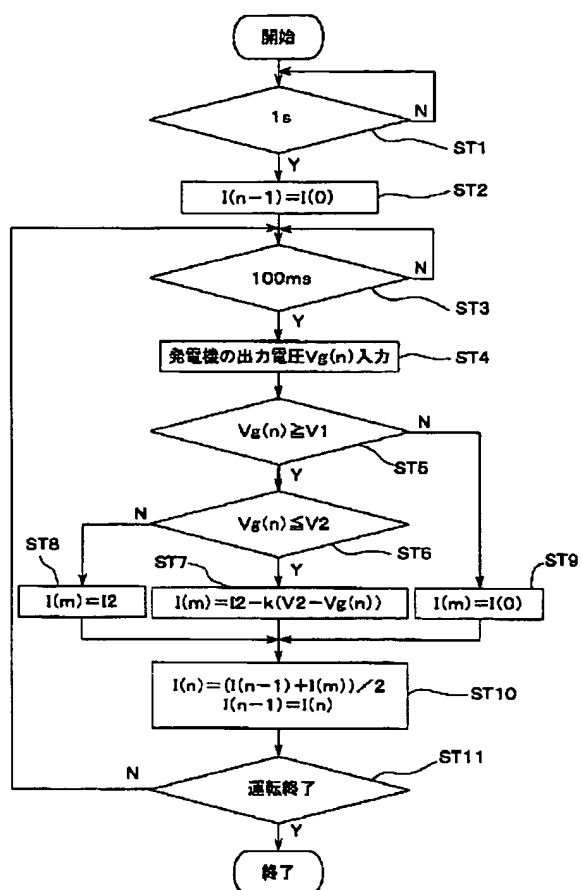
Drawing selection drawing 2



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Drawing selection drawing 3



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